# Technical Research and Blindness : Some Recent Trends and Developments

*By Charles G. Ritter*

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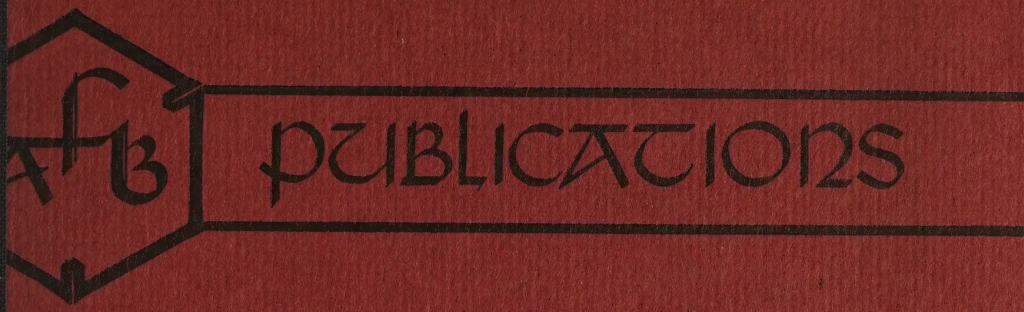


# TECHNICAL RESEARCH AND BLINDNESS

## *Some Recent Trends and Developments*

American Foundation for the Blind
15 West 16th Street, New York 11, N.Y.

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BY CHARLES G. RITTER

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AMERICAN FOUNDATION FOR THE BLIND
15 WEST 16th STREET
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This pamphlet is one in a series of monographs issued from time to time by the American Foundation for the Blind in an attempt to disseminate information on projects carried out by the Foundation and on present-day services to blind persons. The monographs are classified according to their subject into:

1. General Information
2. Preschool Series
3. Education Series
4. Vocational Series
5. Research Series
6. Group Reports
7. Legislative Series

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# Foreword

We live in an age where advances in technical research and developments constantly contribute to making our existence easier and more constructive. Telephones, television, dishwashers and many other scientific achievements have become part of our daily life. They no longer amaze us with their utility or novelty.

The blind person as well as any other member of the human community receives his share of these benefits. He, however, needs some additional special adaptations and much has been done to provide them. It is now only fair that he wants to know what modern science has done especially for him. Also he wants to know where science so far has been unable to produce the hoped-for aid.

The author, Charles G. Ritter, is Consultant, Special Aids and Appliances for the American Foundation for the Blind. Through many years of work with adapting aids and appliances for the use of blind persons and through careful observation of scientific research and experiments bearing on the subject, he is able to present a comprehensive picture of recent trends and developments. His enthusiasm for his work and his many friendships among blind people make him additionally suited for the job. These factors also contribute toward giving this pamphlet the personal stamp of its author.

We feel that blind people, their families and friends and all those interested in the welfare of the blind will find this work a useful guide or handbook.

M. Robert Barnett
EXECUTIVE DIRECTOR

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# INTRODUCTION

Technological developments and achievements have soared to such heights that radically new trends in research towards bettering the life of blind people would seem inevitable. If instruments in a pilotless plane can be read at a distance of miles or hundreds of miles, it certainly appears that a great many of the basic problems of blindness should yield to an assault by researchers equipped with the wealth of the new technologies.

And yet what is significantly new does not come from this direction. We do not yet have a satisfactory reading machine, guidance device, or even color identifier. Indeed, some of the most original thinking along these lines actually antedates the "electronic era". True, there is much good new thinking and some excellent work; but the problems still tend to outweigh the accomplishments.

This booklet will attempt to evaluate what we now have and where we seem to be going. It will try to set forth what is being done, and explain why more has not already been accomplished.

Research today has become costly to a degree that is disturbing. There was a time when a problem need only be suggested to a university research group to elicit more or less tangible results. Graduate students were constantly on the prowl for new research problems. Propose a problem nowadays and back comes a budget. Unless one is prepared to meet that budget, nothing gets done.

All of this means, of course, that more care must be taken in establishing programs of research. When the Prosthetic and Sensory Aids Service of the United States Veterans Administration set up a series of informal symposia on the subject of reading machines for the blind, both private industry and public, college as well as independent research organizations sent their best minds to take part in the discussions. Many of those present were eager for funds to carry on work on one phase or another of the problem. It may well be that concrete project plans will result from such discussions.

A question which will always be asked is, what percentage of blind people would really want a reading machine, guidance device, and so on? It has been estimated that at least half of the entire blind population has passed the age of sixty-five. A surprisingly large proportion of blind persons retain varying degrees of residual vision which respond in varying ways to optical aids. Perhaps a third of those within the American and British definition of blindness can thus be enabled to read newsprint, provided the motivation is present. A very great number retain sufficient vision to travel with more or less security, unaided by any device.

Far better than a study of percentages though is a study of the usefulness to the individual of any device on which work is being considered. If a device can be developed economically to put a bare half dozen people back to work, the value of that device would be hard to overrate. At the same time, the fact that this half dozen succeed in a vocation that might otherwise be closed means that opportunities are enriched for blind people who come later.

This, it seems to me, is possibly the most significant trend in present day research: respect for individual needs and differences. This, in turn, has led to two new fields of endeavor—the search for commercial devices which, with no modification whatever, solve problems resulting from blindness; and the search for other commercial devices which lend themselves to simple modifications toward the same end.

Both precision and automation are playing into the hands of research for the blind. Frequently the gauges required to insure the new precision are much easier to adapt to the requirements of totally blind workers than were the older, cruder tools. Good jigs and good signals frequently eliminate the need for sight.

There must be a constant and intensive study, therefore, of what is happening in industry, in the design fields, and in research laboratories. There must be those alert to see possible applications of the most scattered techniques in the solution of our problems.

Work for the blind has often been criticised for its lack of basic research. May this not, by very definition as far as technical research is concerned, be impossible? If it is research towards improving the functioning of blind people, it is already applied research.

Some such, as regards, for example, reading machines, may be very fundamental. It is easy to think of basic research in the field of psychology, but in the technical field it would be hard to imagine a contributor who would willingly countenance work which had no foreseeable application to the one paramount end: the enrichment and improvement of opportunities for blind people to work and live as happier human beings.

## Braille

Braille has undergone remarkably few changes, technically, since its introduction in the nineteenth century. Printing methods have improved to the extent that paper no longer requires dampening, and interpointing (printing on both sides of the paper) has become common practice with press brailled material. The embossing equipment has been electrified, and high speed rotary presses can now be employed where the production quantities warrant.

A number of problems are gaining recognition. One of the most serious of these is the bulk of brailled material. The International Business Machine Corporation, over the past number of years, has been experimenting with a punched tape form of presentation. This technique was chosen in preference to a photographic film method originally proposed in Scandinavia. The reasons for the choice have not been published, but it can be guessed that they include the fact that much of the teletype and similar existing equipment can be applied; and that the punched type lends itself to distant reproduction over existing press wires, etc.

The prototype unit employs a standard six hole tape, such as is already in use, except that it employs a straight dot for dot sequence. In other words, each hole, ranging from top to bottom, represents a successive dot in the braille cell. With this standard tape, a saving of only a third in space is claimed, but it is felt that a further reduction can result in an overall bulk only a twelfth of that of regular braille. An interesting innovation is the use of fanfold tape to eliminate the need for rerolling the tape after a reading, and to permit skipping.

Such tape would require the use of a separate machine for reading. An endless neoprene belt moves past a window of about a ten-inch length. In other words, ten inches of braille is always exposed. Six metal pins per cell are all in the "down" position as the tape passes the plungers being activated by the tape. These plungers push up the required dots which remain up until they have passed the window, when they are rolled to the "down" position again. The reader controls the speed of travel by turning a knob below the window. The same knob also serves to start and stop the machine. In the prototype model a maximum speed of 150 words a minute is possible, but this is recognized as too slow for many readers. In general, those who have been permitted to play with the machine experience no difficulty in accustoming themselves to holding the hands more or less stationary while the braille passes under them.

A question immediately is suggested with respect to good two-hand readers. It is rather common to have a blind person read a good portion of the succeeding line with the left hand while the right hand is completing the line before. Will a similar sort of skill develop with the continuous tape? In other words, will a technique of skipping develop which will assure the same speeds now possible with ordinary braille? Or will the absence of hand movements make up the difference? These questions cannot be answered until a much speedier machine has been devised.

Another generally recognized problem with respect to braille is the expense of setting up a printing plant. Electric stereotype machines alone, for embossing the braille plates, cost over $2,000, not to mention all the other equipment which is needed. Something is desirable which would be comparable in price (regardless of its limitations) to ordinary office duplicating systems.

Already there is in use at some centers a modification of the old Garin process. In this system, the Uformite Method, the braille dots on an ordinary sheet of paper are filled in with a plastic resin, after which both sides of the page are shellacked. This "master" is placed in a "sandwich" composed of two sheets of heavy rubber and a sheet of paper against the reinforced braille pips. The paper is usually placed in a moisture chamber to soften it slightly in order to secure as sharp an impression as possible. The

Volunteers Service for the Blind in Philadelphia, which developed the method, has issued a children's magazine, and much other material in this form; and Howe Press in Boston is prepared to supply materials suitable for the method, including a braille writer with somewhat deeper than ordinary dies, and a power driven rotary proof press.

Still another method which is in the developmental stage uses silk screen techniques. Plastic master sheets must be pierced to present holes in the position of the required braille dots. These are mounted in a regular silk screen frame, slightly modified, and the "ink" is forced through with a squeegee. Mr. Irving Bonderoth, a silk screen expert, has developed the technique to a rather advanced stage. When the proper paint is used, the resulting dots are quite uniform and smooth to the touch. Indeed, the dot shape achieved offers to beginners some advantages over regular braille.

The paint has too long a drying time at room temperatures to render the system practical, but it can be force dried under infrared lights to the point where it may become an acceptable method. The principle problem now is to find an inexpensive and simple means of perforating the plastic masters.

Another possibility which may be developed along these same lines is to use photographic methods of preparing silk screens for the reproduction of diagrams. This technique would be too expensive to apply to braille alone, but does suggest a number of provocative ideas along illustrative lines.

Vacuum molding of braille, which has been under test for some time in Britain, is beginning to interest some investigators in this country. The technique has been tried on a few games (such as scrabble), and it is well known that rather indestructible braille can be provided in the same form. At first glance, it might seem quite uneconomic in view of the rather marked price difference between plastic and ordinary paper; but if proof-reading costs are added to that of the paper in hand-transcribed braille prepared by volunteers, there is a possibility that such books can be reproduced at a material saving.

It has been shown that ordinary hand-transcribed braille can serve as the master from which plastic braille can be vacuum formed. The paper needs no other preparation than a quick spray

with an invisible stripping compound, and seems not to be affected at all after serving as the mold for twenty copies.

The paper copy is placed, dots up, on a perforated plate over which a sheet of plastic is then clamped. A heating element is placed above the plastic for five or so seconds (depending on the thickness of the plastic). The vacuum is applied to suck the plastic down over the braille. The heater is moved away and seconds later the plastic copy can be removed. For this purpose, only 4 to 5 inches of vacuum are applied.

Interpointing does not seem feasible in this process, but hand-transcribed material in this country is never interpointed so that this is not a serious objection. It may develop that very thin plastic can be employed if sealed back to back with another sheet, which would offer the equivalent of an interpoint book. At present the best results have been obtained on .003-inch cellulose acetate.

Ideas are frequently brought forward by persons interested in helping to reduce the cost of braille printing. Thermographic methods have repeatedly been proposed, but this system does not yet seem capable of producing a dot of good radius. Thermosetting resins have been proposed in a paper base so that the original plates might be done in a standard braillewriter, then hardened.

The fact is that braille is not expensive to reproduce when the quantity involved reaches any significant proportion. Regardless of price, there is not likely to be any great market for braille material in its present bulk. Consider that a dictionary for secondary school use, which in inkprint takes very little space, requires about thirty oversized volumes in braille. There simply is not *Lebensraum* for a braille library at all comparable to what the normal, cultured sighted person would expect to own. Perhaps, then, the very heart of the problem is to find a not too costly means of reducing this bulk.

# Talking Books

The Talking Book has now passed its twentieth birthday, and the list of titles available in the United States alone has gone far over the two thousand mark. It is interesting to note the technical improvements which have come into being. In 1934, when Talking Book machines and records first began to appear, the so-called long-playing record was largely a matter of experimentation. One commercial company issued a few recordings in this form at roughly this period, but stopped manufacture because motors then on the market at reasonable consumer prices were not sufficiently sturdy to eliminate "wow", or undesirable tremolo effects in music; and because the frequency response, the reproduction of overtones, left quite a lot to be desired as the needle approached the center. For radio broadcast purposes, slow speeds were used, but the studios could afford very elaborate turntables, and besides, they made use of only the outer diameters of immense, 17-inch records.

As microphones, pickups, needles and even amplifier circuits were improved, the long-playing discs became increasingly attractive commercially, so that today the old system of 78 revolutions a minute is practically passé. The Talking Book program has in some ways perhaps pioneered many of these developments. It has also benefited from outside work.

The faithfulness of Talking Book recordings is greatly advanced beyond the earlier efforts. The records themselves are thinner and lighter in weight. The machines on which they are played are more compact; the pickups are lighter in weight; semi-permanent needles can now be used; playing time can, when necessary, be increased.

The question is frequently raised as to why tape is not used instead of the conventional disc. An eight hour book, in the form of discs, would take up about 16 records weighing approximately 8½ lbs. (including the 1¾ lbs. of envelopes), and would occupy about 240 cubic inches. On tape, four 7-inch reels would be required,

weighing about 3 lbs. (in boxes), and occupying a little over 78 cubic inches. This assumes that the recording is done at 3¾ inches per second, in two bands per reel. It is not inconceivable that quite satisfactory results would be secured at half this speed, which would reduce the weight and bulk to half. The Blindenstudienanstalt in Germany has, in fact, been producing tapes along these lines.

There are other advantages, too, in that needles are not used, so that there would be no wear and tear from that source. There would not be the gradual increase in surface noise.

But from the point of view of the reader, there are some more or less serious drawbacks. Skipping, for example, is difficult. One cannot easily repeat a passage. One cannot stop reading in the middle of a tape and simply remove it, but must wind or rewind, depending on the portion being read. It is still possible to break tapes. In very high temperatures, the material may "bleed" causing an annoying echo. The tapes are still relatively hard to thread in any machines now on the market. Above all, reproducing equipment is relatively expensive and subject to breakdown under hard use.

There is the possibility that threading of the tape may be eliminated in one of a number of different ways. Some units have already been introduced on the commercial market which do away with threading, although the cost of the tape in its cartridge has invariably been quite high. Abroad there has been quite a bit of endeavor to develop a "cassette" which would not only care for this problem but would also provide for many more lines of recording per tape, making it possible, it is hoped, to put an entire book on a single reel. The American Foundation for the Blind has set up a special project to explore these possibilities.

The problem of a reasonably priced playback machine is still not completely solved. Most tape playbacks, by the nature of the requirements, tend to be rather heavy, and not very much less expensive than a complete recorder. If rapid advance, rapid rewind, quick start-stop are provided, there is considerable mechanical switching, braking, and the like. To keep all this sturdy enough to stand up year after year is by no means as simple as driving a turntable.

Even assuming that mechanical and cost problems with regard to tape have been overcome, and that readers are willing to put up with the inherent inconveniences already mentioned, any change-over in the Talking Book program in this country would take time and involve numerous administrative problems.

Tape is, however, being used at present for some student purposes. One textbook has been recorded under the direction of Professor Thomas Benham of Haverford College, who also issues the new monthly *Science Digest* in this form on a subscription basis. Growing numbers of individual blind persons are also using tape for correspondence, for hobby purposes, and in their work.

Another development on the recording front is the use of so-called embossed discs. In these thin, plastic records, a needle presses a groove into the material (in standard recordings, a chisel cuts a groove from the master). The resultant groove will not hold a needle as easily as does the standard groove, with the result that only extremely free-moving pickups will "track" or hold to the spiral. Some of the regular Talking Book reproducers perform reasonably well with such records, but all are on the verge of skidding across the disc. If the turntable is warped, or if the machine is not sitting perfectly level, the risks are multiplied. A great deal of work is being devoted to the design of a unit which will perform more satisfactorily with embossed discs.

The unit cost of the discs is so low, and the distribution of dictation equipment which will record them is so wide that many volunteer groups now exist for the purpose of recording material in this form for students. A coordinating agency, Recording for the Blind, Inc., has been established and many local groups cooperate with this organization. In addition, the American Foundation for the Blind has experimented with and put into operation a duplicating studio which can make up to thirty copies of an embossed record simultaneously.

This method of recording offers some very real advantages. The discs are extremely compact, and a recorded version would probably take no more space than the print copy. The discs can take braille for labelling purposes. The cost is low and the reproduction cost far less than for pressed recordings.

The fact remains that the medium is a borderline process—al-

ways on the verge of not working—until a more suitable playback machine is developed. When it is, and if it is similarly low in cost, and even more, if it will also play pressed records satisfactorily, then the embossed records may be expected to take on new interest.

Most especially might it have interest for smaller countries, since the cost of a complete installation is quite low and free of excessive technical demands, and the usual quantity limitations do not greatly affect unit costs. There is some reason to hope that new approaches to the pickup tracking problem which are now under way may offer a general solution which will greatly affect the future of the embossed recording program.

## Reading Machines

While the Talking Book goes a long way toward solving the reading problems even of blind people who do not know braille, the fact remains that some one else selects the reading matter. Most blind people yearn to be able to read their own mail, and a great many would like to be able to read other things as well—sometimes newspapers and magazines; sometimes professional material. For this purpose a "reading machine" is necessary.

The first such machine, E. E. Fournier d'Albe's "Optophone", was actually demonstrated before World War I, and a much refined version was completed by 1920. It employed a series of selenium cells which produced different tones as the print was projected against them, and one reader is claimed to have reached reading speeds of forty words a minute.

Such reading machines have no "brains" whatever built into them. They require on the part of the user the mastery of a code which bears no relation to anything he may have learned before. The most that can be hoped is that the sounds presented will enable him to *learn* to distinguish letters or possibly even words. There is no question that some codes might be easier to learn than others; and the best code can only be surmised—probably something which has some of the normal voice components. It is

quite conceivable that a day may come when the new language which had to be learned would be no more difficult than, say, Sanskrit; but not many have been able to learn Sanskrit.

Another type of reading machine which has no "brains" is represented by the Visagraph, which was developed largely by Robert Naumburg in the late twenties and early thirties. This simply made an enlarged, embossed copy of any print material which was put into the scanning device. With new and simpler methods of accomplishing the same end, many feel that this might offer advantages over any code device. For one thing, any type of symbol could be recognizably presented—mathematical formulas, even Greek or Chinese characters. In the second place, differences in type faces, which would affect the output of code machines, would not introduce the same sort of confusion.

A third type of reading machine would be, in effect, an electronic computer which would study each letter, recognize what it was, and then operate a switching device which could turn on a tape recording of the sound chosen to represent that character. Patents have been issued on such machines, and a model was actually built by the Radio Corporation of America under contracts with the Committee on Sensory Devices.

At very best, it appears that this approach is bound to involve a vast number of components. No reading machine of this type can be envisioned in anything resembling a portable size. It is encouraging that there are many uses for print reading machines quite apart from the needs of the blind, and a number of units have already been built commercially for sorting purposes in banks. They have, so far, been required to read mainly numbers; but the accuracy requirements are far beyond those needed in a reading machine for the blind. In addition, the bank units must read travellers checks and documents where printing is done on colored paper and where bank stamps and written notations frequently cover the numerals to be read. This suggests that some of the problems confronting a reading machine for the blind might be less complicated.

If there were no limitations as to size and cost, it is not inconceivable that a dictionary could be built into the reading machine. If this were done, the recognized letters would be as-

sembled in order and compared to the spellings in the dictionary so that when the letters had been matched to a word, the machine would pronounce the word aloud. All this, it is felt, could be done with sufficient speed to provide a rate comparable to ordinary speech. Certain words would, of course, be mispronounced. "Read", for example, would always sound like "reed", regardless of tense. This would probably not present any great problem. There would also be words not found in the dictionary incorporated in the gadget, and these would simply be spelled out.

Since size and cost are very real factors, these possibilities must be listed as mere day dreams. However, it is less unreasonable to think about a machine which would provide a letter-to-letter correspondence in some form of output. Most likely, a coded paper tape would be the intermediate step best deserving of attention. Conceivably, there might be a handful of reading machines of this sort, turning out tapes at a fairly rapid rate for distribution to blind individuals.

Such tapes might then be fed into braille readers such as the International Business Machine tape reader. The braille which resulted would be in Grade I, or full spelling, which may or may not be a serious objection. Currently, all good braillists find Grade I braille quite tedious to read. Whether skipping techniques would develop to the point where such braille would be moderately rapid to read is, of course, not yet known, since no one has the material or the motivation to explore the possibilities.

Alternately, the tape might be used to operate an audio device which would either pronounce the letters, as in a spelling bee, or—more probably—utter sounds more or less corresponding to the most commonly used pronunciation of the letter. Some exploration of possible output forms has already been undertaken, and there are reasons to hope that, as the output is speeded up, recognition of words will become easier.

One useful tool in this sort of study is the University of Illinois "Time Compressor", which was developed for use in the speech studies of Dr. Grant Fairbanks. This Time Compressor, which also has potential applications to Talking Book use, picks up minute slivers of sound from a magnetic tape and pushes them together so that the reading speed is stepped up without affecting pitch. In

the present application, a tape was made on which a trained reader spelled out the words of a newspaper article at a steady rate of speed and in a monotone. When the presentation was sped up by fifty per cent, it was found easier to understand—even without practice—than at the slower speeds. The task of finding the best values to assign to letters is not an engineering concern, but rather one for psychological investigation, and some contracts have already been made by the U. S. Veterans Administration for such study.

Undoubtedly technical problems will be encountered, and many of these are known. They need not be faced too directly, however, till other phases of the problem have shown their hopefulness.

In the modern production of printed books, magazines, and newspapers, coded paper tapes are already widely used, and such tapes are simply discarded when they have served their purpose. The possibility that they could be collected and made available to blind users makes it all the more interesting to explore the output problems as they have already been described. Indeed, if a suitable output machine could be constructed at reasonable cost, and if it were found useable by blind people after a practicable course of training, the available literature would be vastly expanded, regardless of the outcome of the reading machine quest. To this end, some work is going ahead on the design of a separate code translator: a device which will take a tape punched according to one code and produce from it a tape in another. This seems desirable since it is unlikely that translation equipment could economically be built into any of the possible output devices.

Admittedly, even if something is eventually perfected, it will offer only the crudest substitute for normal reading. Who would be willing to tolerate a mechanical sounding, uninflected presentation? And what kind of material would be acceptable in such a form? The possibility must be frankly faced that other means of approach—the Talking Book, a new system of preparing braille, volunteers using tape or embossed recording machines, even systems not currently surmised—may make the quest for a reading machine even less hopeful than it is today.

Or it may develop that the only really helpful device would be

something compact, simple, inexpensive, which would serve no greater purpose than the slow deciphering of a book title, return address, or invoice total. It may prove that the one real need (when the drawbacks of another type of machine are considered) is something that the individual can have in his home and use with no outside help whatever.

Such devices have, from time to time, been created; and possibly the most fertile field would be improvements on these. Professor Thomas Benham, of Haverford College, reports having built a probe with which he was able slowly to trace the shapes of letters. More recently Dr. Clifford M. Witcher at Massachusetts Institute of Technology has devised what he terms the Witcher-Washington Optical Probe. He has not attempted to use this to trace letters, but has successfully followed patterns on an oscilloscope, located pointers of meters, checked margins on a page, and so on. This employs a minute cadmium sulphide photocell to modulate the pitch of an oscillator. If, instead of waiting for something more elaborate, blind people begin employing some such simple device, it is possible that refinements can be added slowly so that there will be a gradual expansion of the things which can be "seen."

Or perhaps developments along the lines of Xerography will make it possible cheaply to produce at low cost and high speed an output similar to that of the Visagraph; or indeed, possibly some of the serious drawbacks of the Visagraph can be eliminated. Or, again, the Optophone approach, which did receive further study in the form of the RCA A-2 Reader, financed by the Committee on Sensory Devices, can be re-studied to produce a machine which will require less skill on the part of the operator. A more recent attack along these lines was made in Canada, where in a crude prototype machine a reading speed of 60 words a minute was claimed for a blind subject after six weeks of practice. This surpasses claims made for any of the other devices.

# Optical Aids

The definition of blindness varies from country to country, depending partly on the state of economic development of the region. In the United States, as in a number of other places, the maximum amount of sight a person may have and still be classed as "blind" is 20/200 in the better eye with correction; or an angle of vision, regardless of visual acuity, not over 20°. The World Council for the Welfare of the Blind has recommended as a minimum international standard maximum sight of 10/200 with correction. In this fraction, the numerator represents the distance at which the eye is tested, and the denominator represents the distance at which a normal eye can read the material seen. Thus, a person with 20/200 can, with glasses, decipher at 20 feet only the top letter of an Eye Chart.

Correction is a term which is now coming to require more careful definition than formerly. By correction is meant glasses; but only such glasses as are designed to overcome refractive errors in the eye. They are intended to place a more or less normal image on the retina.

It is, however, possible to enable many people with serious visual impairments to perform certain tasks as if they had much better sight. A person who, with correction, can barely read the top line of an eye chart at 20 feet can often be enabled to read the entire eye chart with a strong enough telescope. Similarly, for close reading, he can often with a proper amount of magnification be enabled to read the smallest lines on a close reading chart. In other words, with the right device, he may be able to see almost anything seen by a normally sighted person—perhaps fuzzily, perhaps with areas missing—but functionally he can do amazingly well. There are also other limitations. He may have to learn to hold material much closer than normal, maintain it at exactly the right distance, put up with a great deal of head and hand movement to replace the normal eye movement, struggle for adequate illumination and so on.

Many low-visioned people have known this for a very long time. It was not long ago, though, that the fear of eye damage from eye use was widespread. In schools for the blind and in sightsaving classes students were discouraged from almost all optical effort. Gradually, among ophthalmologists the feeling has grown that no permanent eye damage results from eye strain. This has resulted in a rather sudden upsurge in interest regarding what can be done to enhance the usefulness of residual vision.

The American Foundation for the Blind, with consultation and encouragement from ophthalmologists, has been exploring what sight improvement might be possible with magnifiers. The Foundation has had no clinical facilities whatever. Its explorations, however, have brought to light a wide variety of devices which have definitely proved useful to great numbers of legally blind individuals. These range from fairly weak, light-concentrating lenses to twenty-five power projection readers; from simple 2½-power sports glasses to 10-power pocket telescopes.

Perhaps the first agency for the blind to recognize the value of a clinical program was the Industrial Home for the Blind in Brooklyn. Here telescopic lenses, microscopic lenses, and simple high-strength spectacles were fitted to various individuals, and the results have been so encouraging that many other agencies have since planned similar services. It is perhaps surprising that most clients require no more than standard lenses of high strength, used as magnifiers rather than primarily for correction. As high as plus 40 diopter spheres are employed, providing a magnification of 10 times.

Such lenses provide useful vision only at very close range indeed, and the patient is unable to see anything through them at any distance. Bifocal arrangements have accordingly been studied, and up to 32 diopters have been provided in the reading segment. For higher magnifications, Dr. William Policoff of Wilkes-Barre, Pa., has provided multiple-lens spots giving up to 56 diopters (14 times magnification).

More widely publicized have been the air-spaced compound lens microscopic spectacles of Dr. William Feinbloom of New York. He can provide up to 80 diopters in this form, although the glasses must be removed for looking at any distance. Somewhat

similar glasses have been designed by Dr. Edwin Bechtold of Columbia University.

The emphasis, so far, has been on service rather than research; and with a view to standardizing what is now known, and exploring possible improvements, the American Foundation for the Blind has been led to establish a clinical research program which will work with hospitals and medical schools to expand and formalize present knowledge. A National Advisory Committee has been formed consisting of ophthalmologists, optometrists, and other authorities.

It is known that individual requirements influence the choice of aid, and that many persons will not benefit from any optical device, regardless of what they might accomplish with it. A definite learning period is certainly involved for the newly blind and for many of the long-time blind as well; and motivation must be present. It seems possible that factors will be clarified which bear on this phase of the program.

This entire area probably represents one of the most important trends in recent research. Its implications go beyond what can be accomplished for blind individuals. To the general public the word "blind" means a total absence of sight. It can be expected that this work will help broaden the meaning of the lay definition, and that the end results will prove beneficial socially even to those for whom no eyesight remains.

## Guidance Devices

Immobility is one of the most dreaded consequences of near or total blindness, and the search for better techniques for getting about is by no means new. The cane, of course, has been used from prehistoric times; but only recently has training in cane travel become a part of the program of agencies for the blind. The "Long Cane" technique has brought about the development of long, metallic canes of good balance, weight, and appearance. New reflective coatings have increased the visibility of such canes. Telescopic canes have been produced in a variety of forms. The dog

guide, too, has done much to increase the mobility of those who are able to use them, and prejudices among workers for the blind in this regard are gradually fading.

But radar and similar principals have suggested that an electronic device might be harnessed for this purpose, and a considerable amount of work has been expended in the development of a suitable travel aid.

As in the case of reading machines, there is probably quite a bit of haziness on the part of blind and sighted people alike as regards what is really wanted, as well as what is possible. Quite frequently would-be inventors propose mechanical seeing eyes. It is not quite so simple.

The good traveller who is blind tends to a rather large extent to substitute hearing for sight. His cane serves as bumper and step-down indicator, but his orientation largely comes from sound. The first attempts to develop a useable guidance device suffered from the proposed substitution of an audible signal from the device for the orientation data ordinarily gleaned from the unaided ears. Later, touch signals were substituted, with somewhat better results.

Save for one abortive attempt, none of the devices so far suggested or tried attempt to serve as an orientation aid. The earlier units sought only to detect obstacles. Some used supersonic signals, the reflection of which was picked up by receptors in the instrument. Some used high frequency sound waves. The most promising used light.

In order to collect selective data, it is necessary to project a rather narrow beam of energy. Otherwise, the reflected signals would be so scattered that the information would be useless. This means, in effect, that any of these devices is likely to have "gun barrel" vision, a rather dangerous form of eyesight, even with 20/20 at the center. The beam of energy can be directed mechanically or manually to scan the path traversed by the user in order to overcome the narrowness of the beam. Except during exploration, no vertical scansion would be employed in devices now under development. No warning would be given, for example, of low awnings or open truck doors. No information would be given as to the nature of the obstacle encountered.

It is rather generally recognized that step-downs are more haz-

ardous than obstacles, and efforts are being expended on the development of dependable step-down indicators. Indeed, one device, a cane which is being developed at the Franklin Institute in Philadelphia, responds only to step-downs. Tests are being conducted to determine its advantage over a standard cane.

Two other projects are being carried out by blind engineers. Dr. C. M. Witcher is attempting to develop a compact unit which would be housed in a brief case with space for papers and other material in the same case. This would use a mechanical scanning system together with a series of buttons in the handle which would tell to which side an object was seen and, by speeding up vibrations, warn of the approximate distance. A fifth button is to warn of step-downs. Professor Thomas Benham dispenses with mechanical scanning, the user being expected to move the device over a suitable arc. His device also incorporates a series of buttons, but they are intended to give distance information only. As the object is approached, the vibrations shift from button to button. As it stands, the Benham device will detect fairly deep step-downs. For example, as the head of a flight of stairs is approached, all buttons stop vibrating. He hopes, however, to include a more sensitive indicator to warn of curbs and other minor drops in the pavement.

In testing an earlier guidance device which was developed by the United States Signal Corp, Benham discovered that, despite admitted limitations, the instrument encouraged certain individuals to travel alone for the first time. This fact must be taken into account in evaluating any guidance device. If it is assumed that something can eventually be produced which will operate dependably over most situations, and that persons are adequately trained and adjusted to its use, there is no need to argue too much about its relative merits as compared to those of a dog or a cane. There will be some for whom a dog still remains the ideal solution, and others who far prefer a cane. Quite conceivably the fact that the guidance device should be able to deliver information on an area of from eight to ten feet ahead will result in speedier travel with equal safety for good users. And as in the case of reading machines, there is always the hope that if something useable, even in a limited way, comes into wide usage, refinements will come along which now seem unhoped for.

## Study Aids

There is little doubt that among blind students today demands in terms of study have set new patterns. In the first place, thanks partly to federal rehabilitation services, more students are going to college. In the second place, the subjects studied cover a wider gamut. It is not too far back, for example, that most colleges which admitted blind students tended to—or even made it a rule—to waive certain normal requirements. Especially was this true of science and mathematics courses. Today, happily, even the student who wants to receive "special" treatment is likely to find himself obliged to take the same courses as any one else.

There are sufficient tools already in existence to enable the blind student to pass courses in physics, mathematics, chemistry, biology, or geology; but there is little question that more equipment would be helpful. At the moment it seems likely that the vacuum molding process has most promise in this direction. Commercially available relief maps, for instance, intended for sighted students, give the blind student an opportunity for much clearer concepts of the world than have hitherto been possible. These maps, it is true, are much more detailed than educators of the blind have in the past thought feasible, but then, we are dealing with a more mature group of individuals. An individual can be more selective in his study of detail, and may indeed require such detail for his purpose. Blind people cannot, any more than sighted persons, expect to have all the useful information on a single map. It may even prove that blind people will always need some sighted help in thorough map study.

In any case, vacuum molding makes it possible to produce at low cost special maps along with all sorts of other study material for biology, physics, and the other sciences.

Much radio and electronic test apparatus which have been designed and tested await production. The quantitative demands for any specific piece of equipment are likely to be small; but ways and means must still be sought of getting the equipment into pro-

duction. Technical tables of all sorts promise to become more accessible through vacuum forming techniques, and recording methods are gradually being systematized so that much more material can be satisfactorily recorded on tape or discs.

## Aids In Daily Living

Daily living has involved different problems in different ages, and still involves widely different problems for different people. In the eras when the horse was the general means of locomotion, there were blind people—totally blind people—who successfully rode or drove horses. Now that the automobile has replaced the horse for practically all private locomotion, totally blind people, at least, find they must have a driver. Probably no other activity has engaged the daydreams of more blind men than that of somehow being able to drive a car.

Will this ever be possible? Patents have already been issued (and tests made) on a device which prevents an automobile from hitting another car or obstacle head-on. The moment an obstacle is sensed, the car is automatically slowed down. If the driver himself does not then take appropriate steps, the car is automatically stopped. It is conceivable that still more intelligence may come to be built into cars, and that in the science fiction future, some intelligence will be built into highways to help control the behavior of automobiles; but the hazards that are still likely to remain put driving by totally blind people so far off that nothing having to do with this can be said to have any promise.

Changes in daily living as a whole have had a kaleidoscopic effect on blind people. In a general sense, much less is expected of an individual today than in the past. Even the role of the family as a unit has shrunk in importance. Physically, things have become easier, safer, more efficient. Much of this has helped to make function without sight richer. Radios, telephones, and electricity have done a great deal for blind people, as well as central heating, insecticides, antibiotics, typewriters, recorders.

How much all this, and how much agencies for the blind have

done is perhaps not important; the fact is that blind people as a whole expect much more of themselves now than ever before. Many problems have faded, but those which remain have become that much more irksome.

Take color. How often the wish has been expressed, by women especially, that a little gadget might be carried in the handbag which would quickly and unerringly name the particular shade of blue of an attractive blouse. Colors in both clothing and the home have become so much more subtle and varied than they used to be. They can be combined in so many new and interesting ways.

Take fiscal matters. So many more of our dealings today are on paper. The amount of actual money one needs to handle is today a small portion of what is earned and spent. This means that all too frequently other eyes must be borrowed—to read a bill, check a bank statement, go over a contract.

In the matter of personal grooming, life has certainly become more interesting. The woman who eschews lipstick and other cosmetics has come to look "plain." Most blind women can learn to apply lipstick by concentrating on lip sensations rather than what the hand is doing. The new liquid rouges make it fairly easy to apply rouge. Finger nail polish presents a problem for which the majority seem to depend on a professional manicurist or a friend. There seems to be no problem with permanent waves, and many use the home kits with complete skill. Grooming the eyebrows needs only a final, momentary check. It is true that an alarmingly large number of blind women are neglectful in this whole business of grooming, but that is a social and not a technical problem.

For the male, safety and electric razors have been a boon. The sideburns can be kept even by attending to the sensations on the face rather than in the hands. Ties can be marked in some way (french knots, for example). French knots provide a convenient method of marking shirts and socks as well.

Spot removal and indeed even spot detection has no solution. The blind person is likely to have higher cleaning bills—not from clumsiness, not from spilling things perhaps, but simply to play safe.

## Homemaking Aids

Nowhere is the blind person better off today than in the home, for here gadgetry has come to its fullest bloom. To an astonishingly large extent, the devices to simplify life for people with sight have also simplified life for those who are blind.

There is one respect in which the manufacturers have yet to learn useful truth. As a warning signal, sight is inferior to hearing. Manufacturers of pressure cookers know this. The first pressure cookers had visual indicators. The housewife would be busy away from the range and was forced to keep going back. Sometimes she forgot to go back. Those were the days when pressure cookers were supposed to be dangerous. Now pressure cookers have audible gauges, rendering them useable without sight. Accidents have fallen to just about zero, and thousands of blind housewives are using pressure cookers.

Gas stoves have always presented some problems, and as a consequence electric stoves have become more popular with blind women who could afford to make a choice. The one trouble with electric stoves has been that they were slow to come to full heat. The newest electric stoves have overcome this drawback. At the same time, the newest gas stoves have improved so that they do not present the problems of the old ones. It is now possible to buy a gas stove on which the temperature dials for every burner can be marked for accurate setting without sight.

Blind people can and do of course cook on all sorts of stoves without any serious problem, from barbecue pits to wood, coal and oil stoves, to hot plates and gas burners.

There is a trend toward decentralized cooking. No longer need all the heating units be lumped in one unit. Toasters, broilers, controlled heat frying pans, electric pressure cookers, electric deep fryers, waffle irons, and the like make it possible today to prepare a full meal without going near the stove. Where other cues do not exist, or where they are not already modified, the controls may be marked with escutcheon pins, CVH Relievo Paint or the like.

Then there are the prepared food mixes. The blind housewife can today make an angel food cake that would have put her mother to shame without separating a single egg. She can bake a pizza or a pan of popovers, or brownies. She can buy half-baked bread or frozen cookies and finish them in her own oven. She can secure anything from asparagus to collard greens already cleaned and frozen with assurance that there will be no stray insects or undetected blight.

The one thing she needs, of course, is a way of marking everything. A frozen package of lima beans to a blind person looks exactly like a frozen package of mashed potatoes, and a box of ready-mixed devils food cake may look exactly like a box of corn starch. Canned goods often "look" alike, even when shaken for the sounds the contents make. Plastic labels are available which can be marked with braille (or an arbitrary code in dots if braille has not been learned), and these can be attached easily with special elastic strips.

Of course, braille does become more essential. Some manufacturers have begun to offer braille booklets on their products. It is hoped that plastic recipe cards will soon become available for the various food mixes. It is always convenient to be able to mark herb jars. Experiments are being made toward a permanent, transparent, self-adhering plastic label which can be brailled to suit individual needs.

New aids are coming along for sewing. Many blind housewives make clothes, mend, hem curtains, etc. The big unanswered need here is for useable patterns. Pattern manufacturers have been approached, but there are so far insurmountable obstacles. It may be hoped, however, that other solutions will still be found. Some women have patterns copied on heavy paper. Low-visioned women may have the outlines of existing patterns marked in a color which contrasts to the material of the garment.

Without any question, the most difficult aspect of homemaking is cleaning. New detergents, new equipment, new basic materials all help, but there remain many points at which a pair of eyes are just about indispensable. The melamine plastic dishes, for example, appeal to some blind housewives because they are not easily broken. They have one major drawback: they sometimes stain.

Some of the powder bleaches will remove such stains, but touch alone is of no value in insuring a perfect job. Similarly, stains on woodwork or porcelain, not to mention clothing, often give no non-visual signs of their presence.

Vacuum cleaners have become vastly easier to manipulate. The tank type are currently being provided with wheels which make them easier to pull about, and the flexible hose gives a greater sense of freedom in covering a floor or, indeed, shelves, window sills, and so on. Many have expressed satisfaction, too, with the so-called electric broom where the power-driven brush does most of the work while a slight suction collects the dirt. In cleaning windows, some of the new products leave a dull film which is then rubbed off. The shiny condition of the glass can be checked through the cloth or chemically prepared "paper" parchment. Similarly, the new silicone furniture polishes have been the same kind of boon.

Automatic washing machines have made it fairly safe for the blind housewife to do her own laundry, although occasional checks by a sighted friend are desirable. Mildew and other stains cannot always be detected, and special treatment may be required on shirt collars and cuffs. Ironing with most modern irons is fairly simple. Many of the temperature controls can be set without modification, and even the circular ones can be marked with a dot of plastic paint so that the settings can be related to the dial of a clock. Most housewives have no trouble in handling electric mangles.

The one great difficulty, apart from cleaning, is shopping. How does one know of new products? Here it seems likely that television is a better source of information than radio. Even if the screen cannot be seen, the accompanying talk is usually adequate to form a picture, and far more products are demonstrated in television than were ever described on radio. Certain programs are especially helpful in this respect, and the housewife does well to learn which they are and to watch them.

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## Work Aids

Many of the basic processes already mentioned apply to work tools. One criticism which is frequently made—or one wish that is often expressed—is that there should be more precision measuring apparatus. The truth is that in industry much of the apparatus and most of the operations must be special to that application. Often only a slight modification is required for a blind worker. If the basic processes already available were better known by placement people, it seems probably that many more jobs would be immediately opened.

Special devices, of course, can serve two functions: they can enable a blind person to do a job, and they can persuade an employer that the job is possible. Frequently, a special guide or templet must be made to enable a blind person to secure a certain position in industry or business only to have it develop later once the individual starts his work that a simple technique or occasional passing help from a fellow employee renders the device superfluous.

There exist measuring devices for length, weight, temperature, time, relative humidity, barometric pressure, blood pressure, voltage, current, resistance, capacity. Accuracy is often beyond standard commercial requirements. So far as is known, only one set of tools exists for making the tests required of a rubber chemist, but so far as is known there is at the moment only one blind rubber chemist, and even he is not using his equipment very much since he has been promoted to plant manager.

A really satisfactory carpenters level is not in production, and yet many blind people have made their own levels based on plans which are freely available. No rain gauges have been adapted since anyone who has occasion to gather such information can work out tables so that he will have better accuracy by weighing the precipitation. No pump thrust gauges are offered since an existing ruler can be so easily adapted to that purpose and will provide better measurements than a standard pump thrust gauge.

It seems likely that automation will carry with it many techniques which will help put blind people to work. In an address before the National Association of Manufacturers several years ago Maurice Hull, of International Harvesters Corporation, pointed out some very cogent facts about the need for sight in production. The need for sight is often a drawback. If sight can be rendered unnecessary, production is bound to rise, and the number of rejects to drop. For sight requires judgment; that takes time; it may not always be properly applied. If a jig or a tool can take over the role of sight, that is always better.

On the way to automation there is a breakdown of jobs into all their factors. Time, temperature, placement, pressure, etc., must all be controlled. Frequently the methods which are evolved open up new job opportunities to blind people.

## Recreational Aids

This is not an area where intensive research suggests itself to many of those outside work for the blind; and even inside the field, it cannot be said that many feel that crying needs exist. Nevertheless, a constant search for new games is carried on.

Take crossword puzzles. Over the years, blind people have repeatedly expressed a strong wish to be able to work on such puzzles. The general feeling in America is that no really satisfactory solution has been forthcoming. In France various serious efforts have been expended, and two designs were on the market for a time. These, however, involved setting individual pins for each dot of the cell, so that playing was most time-consuming. In the United States, a volunteer at one time offered for sale boards with sunken squares and characters of linoleum with escutcheon pins to represent the dots. Cork squares were employed to represent blanks.

The principle of the cubarhythm slate has been proposed. Four cubes would be needed to represent the complete alphabet, although three would be sufficient if one were willing to substitute Grade 2 signs for Y and Z. Existing cubarhythm slates are too small

for a standard puzzle, so special boards would have to be made. To facilitate play, the ranks and files on the board would need braille markings, and even then the blind player would have to keep a lot more information in his head.

Next, the puzzles would have to be put into braille. This would involve first instructions for establishing the blanks. Then the puzzle itself would follow. A constant supply of new puzzles would be required. After each puzzle had been solved, the cubes would have to be sorted before the next could be begun.

Actually, if the puzzles were available in braille, it would be perfectly possible and require very little additional effort to work out solutions on a braille writer. The Perkins Brailler is ideal for this purpose, and the older American Foundation for the Blind machine can be used satisfactorily.

Another frequently voiced request is for a good noisy ball. The British have from time to time offered partial solutions, and one commercial American producer of rubber balls at one time offered an inflated rubber ball with a bell suspended inside. He discontinued production for two reasons: the bell too frequently tore loose, and the market in any case was too limited.

The problem is not an easy one. If a game is really active, the players themselves, not to mention the spectators, drown out the noise of the bell with their own calls and cheers. In too many instances, if the ball is in rapid motion, inertia keeps the bell silent. If there is any delay in play, the ball comes to rest, and the bell falls silent. If the ball is to retain its bounce, the walls must be solid, and the ball covering tends to muffle the sound.

The suggestion has been made that the ball house a siren and that this be so designed that each player, by pressure, can rewind it. Or air scoops have been suggested which might cause a whistle to sound.

There remain, however, such a wealth of games and activities that these unsolved problems do not seem over-pressing. For the preschool or young child, toys in general have improved to the point where plenty of play-interest survives with no special modifications. For the active adult, while team games as such are pretty well ruled out, there are many remaining activities such as rowing, swimming, riding, skiing, golf, bowling, shot putting, wrestling,

and the like which can be carried on with little or no assistance. A portable bowling rail is the only special piece of equipment which comes to mind.

In the way of social games cards, of course, have been marked from time immemorial in various ways. Checkers and chess can be played with slight modification in the equipment and do not require a knowledge of braille. Chinese Checkers, dominoes, and a few similar games are also available in a slightly modified form. Bingo boards can be had, as can a game of fairly recent origin called Scrabble, which can also double as an anagram game when extra tiles are secured.

Perhaps the greatest need exists in the way of solitaire games suitable for elderly persons. Here, it is rather important to avoid the use of braille since so few of those whose vision is impaired at an advanced age have adequate motivation for mastery of point reading. The competition which such games must face from radio, television, motion pictures and so on, has gone up tremendously in the past few decades, and perhaps the real trend in this direction is away from games and puzzles as recreational needs. The radio and television programs which can be enjoyed without sight have multiplied to the point where the hands no longer need to be kept occupied. Talking Books have done much to occupy the minds of older blind people. Geriatric recreation groups are gradually increasing in number, and where some insight is present on the part of the group workers, blind people do not experience any great difficulty in fitting into such groups.

## Prosthetic and Medical Aids

Where blindness is the sole disability, there is probably no great need for research into medical aids. Some blindness entails the constant use of eye drops, may require medicaments which must be kept chilled, but these present no real problem.

Often, however, blindness is one aspect of a systemic disease, as in diabetes or Hansen's disease (leprosy) or multiple sclerosis. Diabetes, particularly, accounts for more blindness today than at any

time in the past. Indeed, some feel that it now approaches glaucoma as one of the major causes of serious visual impairment.

In the case of diabetes, there is the problem of insulin administration. This is now fairly well under control except where an individual is required to take mixed doses of different types of insulin. Syringes with devices for locating the center of the rubber cap on the insulin vial and automatic injectors are available. For other purposes there are clinical thermometers and drop measures. Where the malady involves other disabilities, or where other disabilities are complicated by blindness, not too much practical research has yet taken place.

In Hansen's disease, for example, by the time blindness occurs (in the future it should ordinarily be preventable with existing medicaments) the hands are usually involved to the point where touch is completely deadened. The patient will not feel fire, much less other things such as braille. There appears, however, to be another sense in the fingers which might still be tapped. One can still feel traction. One can feel resistance. One patient with extremely affected hands was unable to tell a dime from a fifty cent piece although he could still distinguish a dime and a penny by the milling on the edge of the dime and its absence on the cent. In some diabetics there is, to a lesser degree, this same deadening of the sense of touch.

The hand amputee who is blind faces certain new problems from the combination of disabilities, as does the hemiplegic, the multiple sclerosis patient, or the cerebral palsied. Except for the deaf-blind, actually, very little has been accomplished for any of the multiply handicapped blind groupings.

Helen Keller, more than perhaps any one else in America, has helped bring into focus not only the needs of the deaf-blind, but the potentialities as well. Today, for example, growing numbers of deaf-blind persons are finding employment and the need has been met for a suitable alarm clock which would shake the bed at the proper time for rising. A conversation device, the Tellatouch, has been developed to activate the appropriate braille symbols from a key board similar to the typewriter key board. For those who have partial hearing and who have not been able to employ

standard hearing aids, modifications have been worked out on the old-fashioned speaking tube.

Serious efforts have been made to extend sense shifting so that sound could be converted into touch. Mere conversion is not difficult of course; the problem is to render the resulting tactile stimuli meaningful. An extended needle in a recording head, even the button on certain types of headphones, readily apprise the user of every sound when coupled to an amplifier and a microphone, but the vibrations tell very little. Rhythms of music, in fact, can often be picked up by placing the fingers on a tin or cardboard box. Dr. Keller has reported use of a balsawood sounding board to the same ends. It is even reported that a platform has been suspended in such a way as to be vibrated by the output of a powerful amplifier, but this elaborate approach was apparently not much better than the simple box.

In Holland, Dr. Gerritt van der Mey has experimented, in consultation with telephone engineers, with a device using filters and vibrating buttons as a means of recognizing the presence of traffic. While he does not recommend such an approach for others, he uses it in certain situations, claiming that he prefers sudden death to the slow decay of immobility. This deaf-blind individual is apparently the first to earn a Ph. D. in mathematics.

Dr. Norbert Wiener and associates at Massachusetts Institute of Technology have experimented with electronics devices for speech recognition by the deaf-blind, and new approaches are currently under consideration toward the same end. In the early experiments, the speech spectrum was broken into rather well-defined frequency bands, and a series of carefully located stimulators were placed about the wrist. "Feelix", as the gadget was called, proved extremely exciting to some of the deaf-blind on whom it was tried. Work on speech analysis now under way at Haskins Laboratories as well as at the Bell Telephone Laboratories tends to encourage some degree of hopefulness for eventual working devices along this line.

There is a growing awareness of the importance of the whole individual regardless of what configurations of disabilities he must live with. Quite often the geriatric problems of an elderly

blind person outweigh those imposed by blindness. Specialists in increasing numbers and in more widely scattered fields are beginning to exchange ideas and information.

As each loses his fear of the other disability, it seems probable that problems will gradually be solved. Efforts are currently under way to interest psychologists and others in the development of tests to explore the various sensoria more thoroughly than has hitherto been possible. These in turn will help define the problems more explicitly. Moreover, the patients themselves begin to gain a healthier picture of what they can do, which is perhaps most important of all. For the fact is, gadgets and devices aside, when the human mind and will are functioning it is beyond understanding what can be accomplished.

## The Far Future

Aside from devices for the partially sighted, everything so far mentioned aims at transferring visual functions somewhere else. The duties of the eye are shifted to the ears or to the senses of touch or smell. Such a procedure will always have its limitations. There are many things no sense can handle as well as the sense of sight.

The ultimate hope, therefore, has to be that some means will yet be found for restoring in some measure visual function. The general public is prone to believe that eyes can be transplanted. Even if the eye and all its related parts were mechanical lifeless units on which an expert could spend years making mechanical connections, this is beyond hope. There would be millions of connections to make in an area that makes mockery of our best dreams in miniaturization.

The optic nerve alone is one of the most destructible tissues in the body, and it never recovers from damage. It appears, further, that deterioration in the optic nerve follows rather closely on loss of visual function. This process seems likely not to be reversible.

Those who care to ponder these matters feel that there is much more hope, ultimately, for useful stimulation of the visual cortex. Cups on the optic nerve, even if they were possible (and it has

been shown why they are not) would necessarily apply stimuli so grossly and erratically as to show no promise. On the cortex, however, the optical elements are relatively spread out and there might be possibilities there. One eminent neuroanatomist has gone so far as to propose laying mosaics of electric contactors against the surface of the visual cortex and then studying what could be done with them.

Undoubtedly a great deal of apparently unrelated research which has taken or is taking place has some bearing on an ultimate program along these lines. But it is a subject so involved and with work so widely scattered among so many disciplines no one has yet devised a way of even bringing together the pertinent data which has already been gathered. A good research man with an adequate travel budget could easily be kept busy full time on this and nothing else, with no conceivable hope of seeing concrete achievements in his own lifetime.

It seems inevitable that if visual impressions could indeed be achieved in any way along these lines, they would be of the crudest sort. Patients whose cortex was explored during operations with a 1/16-inch silver electrode reported seeing flashes of color (blues and greens mostly), or colored form, or even a colored hand or leaf or the like. Man's efforts to duplicate some of the functions of the human brain, of which the eyes are a part, have ended up so far with whole rooms full of expensive, intricate apparatus. When it comes to trying to duplicate only in part the messages sent to the cortex by a normal eye, the problems are truly staggering.

It has been proposed repeatedly that visual messages be given in pattern form through heat or touch—say against the forehead or abdomen. This would indeed be simpler than trying to present patterned information to the cortex were it in fact possible. But sensory patterns so presented do not show promise.

In his constant quest for knowledge, man may yet some day learn all that he needs to know to restore literally some vague kind of sight. Within our own lifetime he has learned to waft visual images through the air for people to watch on television screens. He is learning to convert sight into magnetic impulses that can be stored on a piece of brown plastic tape. On the engineering side he is moving ahead at a dizzying pace.

On the physiological side, progress in other fields is equally rapid. Sometimes the very progress produces blindness as in Retrolental Fibroplasia, and then after a bit more progress, that blindness begins to disappear. Some very basic and elusive knowledge may yet develop which will put engineering and medicine together to yield a crude kind of sight for the totally blind.

So far, there isn't even a trend this way. So far there is not much more than a hope. But as long as the wish remains, who can say when scattered research will not flow together to point new ways?

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HV1701 Ritter, Charles G.
R514 Technical research and
blindness: Some recent
trends and developments.

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